Higher Twist Contributions To R-Hadron Phenomenology In The Light Gluino Scenario*

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The gluino is the supersymmetric partner of the gluon. It is an electromagnetically neutral, adjoint fermion with the same color structure as its boson counterpart. As yet, no clear experimental evidence of supersymmetric particles has been found, perhaps due to the large expected mass of the supersymmetric particles ($\Lambda_{\rm SUSY} \sim 1$ TeV). However, the possibility exists that the gluino is not only the lightest supersymmetric particle but also very light compared to the SUSY scale, $m_{\tilde{g}} \ll 100$ GeV.

Light gluinos are predicted to form relatively light bound states of quarks or gluons and gluinos called R-hadrons. The lightest predicted R-hadrons include mesinos ($q\bar{q}\tilde{g}$), two barinos, $R^+(uud\tilde{g})$ and $S^0(uds\tilde{g})$, gluinoballs ($\tilde{g}\tilde{g}$), and the glueballino or R^0 ($\tilde{g}g$).

There have been many theoretical and experimental attempts to find evidence for and/or exclude the light gluino scenario. Searches for R-hadrons produced in fixed target experiments have been performed for a number of the predicted R-hadron decay channels. Effects of a light gluino on QCD observables have been analyzed. A brief summary of the various possible resulting constraints on a light gluino is given in Ref. [1]. Although these various analyses are, in combination, potentially sensitive to most regions of light gluino mass, all rely on model-dependent inputs. As a result, we believe that at present it is impossible to definitively exclude any gluino mass below $4-5$ GeV. Thus, it is of great interest to find additional approaches for discovering and/or constraining light gluinos and the R-hadrons.

We explore the possibility of detecting R-hadrons at large x_F in pp and pA fixed-target interactions. Our calculations are restricted to the $m_{\tilde{g}} \sim 1.2-5$ GeV region where we can be confident that the semi-perturbative techniques that we employ are reliable. This region is of particular phenomenological interest because of the analogy that can be drawn between heavy quark and light gluino production.

In analogy with leading charm, we study R-hadron distributions using "intrinsic gluinos" ($\tilde{\rm IG}$) in regions of phase space where higher twist effects cannot be ignored. We calculate enhancements over the leading twist R-hadrons x_F distributions with gluino masses $m_{\tilde{g}} = 1.2$, 1.5, 3.5, and 5.0 GeV. Both pp and pA interactions at $p_{\rm lab} = 800$ GeV are considered.

We assume a "maximally leading" scenario for final state R-hadrons in pp and pA interactions at 800 GeV. Our model predicts that the contributions of higher-twist intrinsic states lead to strong flavor correlations between initial and final states for $x_F > 0.6$. The large intrinsic gluino enhancements at high x_F over the leading-twist predictions imply that this region of phase space could be especially appropriate for R-hadron searches in the light gluino scenario. For $m_{\tilde{g}}$ in the $1-5$ GeV range, a mass region where substantial evidence for the analogous intrinsic heavy quark states exists and for which our computational techniques should be most reliable, the enhancements are very significant (factors of several hundred to several thousand being common). The magnitudes we predict for these enhancements may even be conservative since the increased color factor associated with intrinsic gluinos compared to intrinsic charm has been neglected.

[1] L. Clavelli, UA-HEP-99-4, hep-ph/9908342.

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